

E & A

MP LIBRARY
16 DEC 1932
USA. 69
AL
ARATE

CIRCULAR No. 226

JULY, 1932

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.



CONTROL OF THE TURPENTINE BORER¹ IN THE NAVAL STORES REGION

By J. A. BEAL, Assistant Entomologist, Division of Forest Insects, Bureau of Entomology²

CONTENTS

	Page		Page
Introduction-----	1	Comparison of turpentine meth-	
Nature of injury-----	3	ods and conditions favoring at-	
Description and life history of the		tack-----	12
insect-----	5	Control-----	16
Economic importance and extent of		Summary-----	17
injury-----	7		

INTRODUCTION

The naval stores industry is one of the most important of all forest industries. In terms of the value of its products it is second only to lumbering.³ In the past it has been characterized by destructive methods that have resulted in the depletion of the forest under their application. However, losses to the industry are gradually being reduced by better methods of turpentineing.⁴ Through research a way has been found to work trees for a longer period, therefore the continuous operation of turpentine orchards on a long-time basis is becoming more prevalent. With the tendency toward a more general use of improved methods has come an increasing demand for information on the protection of turpentine trees from injurious forest insects. This bulletin is designed to supply such information regarding one of these insects.

It has long been recognized that insects present a serious problem in the turpentineing regions; that dried-out faces of turpentineed

¹ *Buprestis apicans* Herbst; order Coleoptera, family Buprestidae.

² The writer wishes to express his appreciation of the aid and cooperation extended to him at the places visited during this study, and particularly to the following for assistance in the work and for information on methods and practices: F. C. Craighead, chief of the Division of Forest Insects, under whose supervision the work was conducted, and who spent much time in the field on this problem; Lenthall Wyman, silviculturist of the Southern Forest Experiment Station, U. S. Forest Service, who cooperated on the problem throughout its course; also to other members of the Southern Forest Experiment Station, especially V. L. Harper; E. R. McKee, deputy supervisor of the Florida National Forest; and I. F. Eldredge, formerly of the Forest Service, who gave considerable aid in discussing the development of the operations and explaining the development of technic. In addition, the aid and cooperation of many other members of the Forest Service are greatly appreciated.

³ BROWN, N. C. FOREST PRODUCTS, THEIR MANUFACTURE AND USE; EMBRACING THE PRINCIPAL COMMERCIAL FEATURES IN THE PRODUCTION, MANUFACTURE, AND UTILIZATION OF THE MOST IMPORTANT FOREST PRODUCTS OTHER THAN LUMBER, IN THE UNITED STATES. 471 p., illus. New York, 1919.

⁴ WYMAN, L. EXPERIMENTS IN NAVAL STORES PRACTICE. U. S. Dept. Agr. Tech. Bul. 298, 60 p., illus. 1932.

vi, 422

trees, especially those that have been burned, become badly damaged by heavy borings. However, the full significance of this type of damage has not been generally appreciated.

A cooperative study by the Bureau of Entomology and the Southern Forest Experiment Station of the United States Forest Service has revealed the nature of the most serious insect damage to turpentine trees. It has also brought out methods of control best adapted to the life history and habits of the insect responsible for the damage and to modern practices and methods of turpentine.

Undoubtedly the most destructive pest of turpentine orchards in the South is an elliptical beetle (fig. 1), the turpentine borer, known

by the scientific name *Buprestis apricans* Herbst. The heavy losses caused throughout the naval-stores region by this insect have brought it to the attention of timber owners, foresters, and entomologists.

The larvae (fig. 2) of this insect tunnel beneath the turpentine faces or attack trees that have been scarred by fire or otherwise injured. Many trees of the long-leaf pine (*Pinus palustris* Mill.) and the slash pine (*P. caribaea* Mor.) of the Southern States have a large portion of their butt sections riddled by the flattened, oval wormholes, or mines, made by this borer. The mines wind through the sapwood and heartwood of the main trunk of infested trees and not only render much of the timber worthless except for fuel but also weaken the trees so that they break off easily, and many of them fall, especially during severe windstorms.

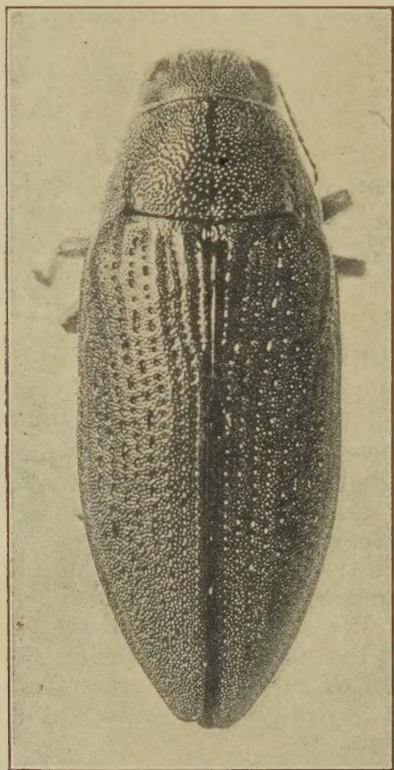


FIGURE 1.—Adult of the turpentine borer (*Buprestis apricans*). $\times 2\frac{1}{2}$

in which the borers have worked. The borers are especially destructive behind the turpentine faces and extend their work above them.

The turpentine borer is also responsible for reduced gum production, chiefly in thin-sap slash pines. In heavily infested trees the borers often mine so close to the surface that back faces fail to produce gum and are of necessity abandoned.

During periods of keen competition and relatively low prices on naval-stores products the difference between success and failure may depend upon the operator's skill in eliminating losses caused by waste, inefficient methods of operation, and insects. It has been demonstrated that losses from the turpentine borer can largely be pre-

vented by the use of conservative turpentine methods, such as are advocated by the Forest Service, and by the protection of abandoned faces from fire. These methods are discussed under Control.

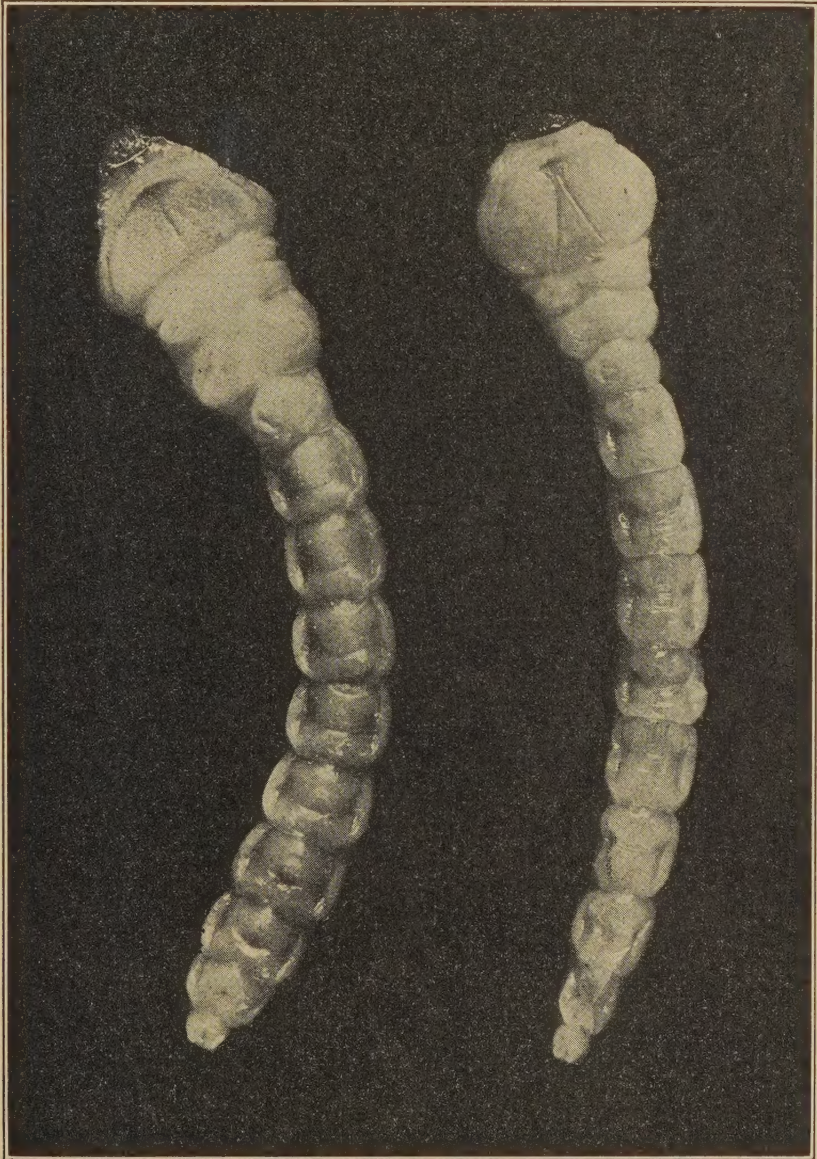


FIGURE 2.—Mature larvae of the turpentine borer (*Buprestis apricans*). $\times 2\frac{1}{2}$

NATURE OF INJURY

The young borers feed, for a period of at least three years, by mining back and forth through the sapwood and heartwood of the trees. (Fig. 3.) During the long period of larval feeding a single

grub is capable of doing a considerable amount of damage. The tunnels are small during the first year, and the larvae do not mine very far into the wood, usually not more than an inch or two. However, as the borers grow and work more rapidly, the tunnels increase in size and penetrate farther into the wood. The mines are oval and from one-fourth to one-half inch in diameter. They wind back and forth through the sapwood, deep into the heartwood, and back to the surface again. They are usually filled with a dense mass of fine pitchy borings, except where they terminate near the surface of the wood and in the enlarged pupal cell and exit hole. Heaviest injury occurs in a band of rings where the heartwood and sapwood meet. Completed larval galleries range in a vertical direction from

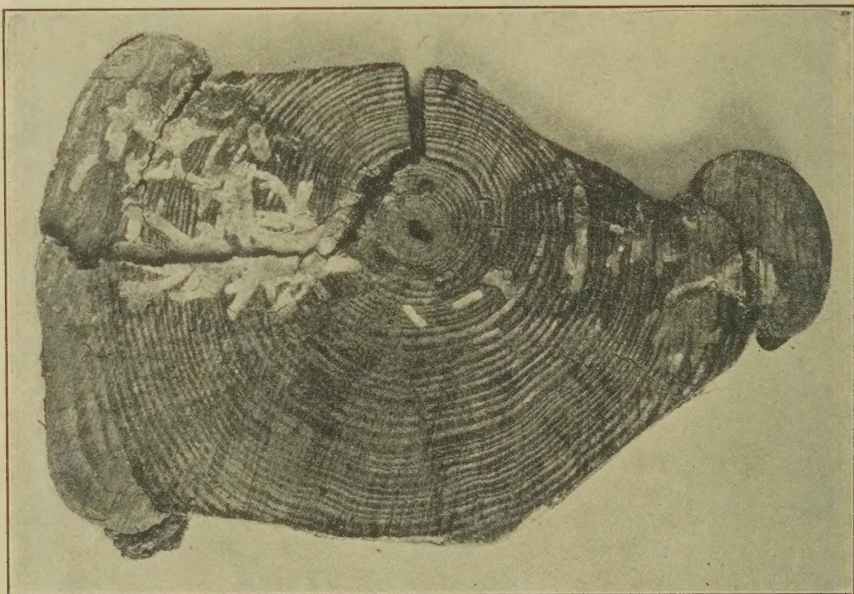


FIGURE 3.—Cross section of a back-cupped pine showing larval tunnels of the turpentine borer that attacked the burned face. This tree broke off at the point of heaviest borer damage, 2 feet above the saw cut

10 to 33 inches and extend back and forth through the tree. Their average length is 21 inches, running 9 inches above and 12 inches below the emergence hole. The mines also extend from 6 to 9 inches above the exposed faces. The short galleries, because of their more tortuous routes, cut off approximately as much wood as do the long galleries. It is not uncommon to find as many as 25 to 50 larvae of various ages and sizes in a single exposed tree, working in an area 2 or 3 feet in length.

The activity of the larvae within the wood of the tree causes a heavy flow of pitch in and about the injured places, and the wood in the vicinity of the galleries becomes heavily impregnated with resin and is commonly referred to as "lightwood." Without considerable chopping to expose the deeper layers of the wood it is often impossible to recognize infestation until after three years or more, when the adults have emerged. The elliptical emergence hole, which is

nearly one-half inch across the long axis, and the larval mines in the wood are positive indications of infestation.

After emerging in the spring, the adults feed on the pine foliage (fig. 4), but this form of injury is not easy to identify. However, pines felled during March and April in the vicinity of infested timber often show evidence of feeding on the needles. This injury is of minor economic importance, since a relatively small portion of the foliage is eaten.

DESCRIPTION AND LIFE HISTORY OF THE INSECT

The turpentine borer (*Buprestis apricans* Herbst) belongs to the group of insects commonly spoken of as flatheaded borers (Buprestidae). They are so called because of the characteristic appearance of the larvae or grubs. The larvae, which represent the most destructive stage of the insect, are long whitish grubs (fig. 2) with a

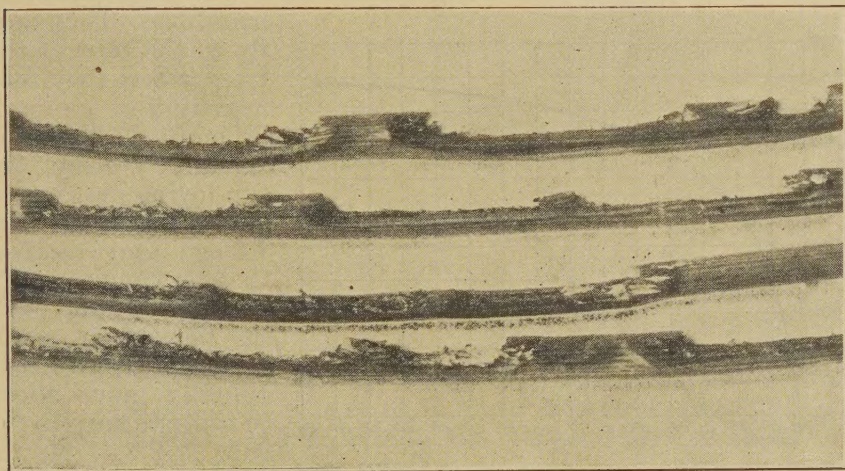


FIGURE 4.—Pine needles showing results of feeding of adults of the turpentine borer (*Buprestis apricans*). ($\times 6$)

broad, flat segment just behind the head, a character which readily distinguishes the young of this family from other wood borers and gives them their name "flatheads." Mature larvae are about $1\frac{1}{2}$ inches long by three-eighths inch across the thorax (the broad, flat segment just behind the head). The plates of this segment are roughened over their entire surface. The dorsal, or top thoracic plate, is marked by a short-trunked Y and the ventral plate has a deep median groove which extends from the posterior margin about half way to the anterior one. The color is creamy or dull white.

The adult is a grayish-bronze elliptical beetle with a greenish metallic luster which gives it a rather striking appearance. (Fig. 1.) It has eight longitudinal rows of large punctures on each wing cover. It is slightly flattened and oval shaped, and ranges from three-fourths to $1\frac{1}{4}$ inches long by one-fourth to three-eighths inch broad.

The adults pass the winter in their pupal cells from one-fourth to one-half inch below the surface of the wood of turpented faces. Observations on this species in different localities, together with the dates of emergence of adults on 100 marked faces near Starke, Fla., show that the emergence of the mature beetles occurs during the first warm days of spring (late February and early March). Unusual weather conditions prevailing during the spring of certain years may put the period of emergence earlier or later than that given here. However, it occurs at about the time the papaw (*Asimina triloba* L.) is in bloom. Figure 5 shows the emergence on part of the Kingsley Lake tract in the vicinity of Starke, Fla., during 1928 and 1929. It is significant that all the emergence took place in a period of about three weeks, but, even more significant, that most of it occurred within the first two or three days of the period, the heaviest emergence, in each case, being on the second day.

The beetles eat their way out through the tough wood by rotating themselves in their cells and biting out the wood with their powerful

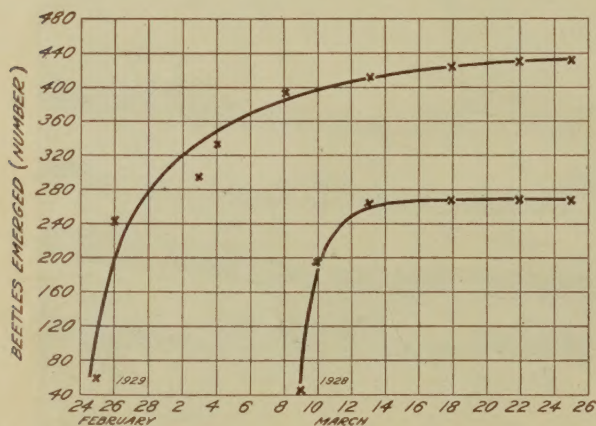


FIGURE 5.—Cumulative emergence of the turpentine borer on the Kingsley Lake tract, Florida, in 1928 and 1929

mandibles. They then fly to the tops of the trees, where they feed heavily for a month or more on the pine foliage. They are sun-loving insects and feed chiefly on the foliage that receives the maximum daily sunlight. In the feeding cages on small pines the beetles continually move about in order to keep in the sun. The beetles mate during the feeding and flight period, after which the females seek exposed wood on burned or dry faces, cuts, gutter insertions, or checks of any sort, in which to deposit their eggs. The adults have been observed running around over the exposed faces and testing the crevices with their ovipositors as late in the summer as July. They die during the summer of their appearance; therefore, renewed attack depends upon the emergence of new beetles the following spring.

The eggs hatch in a few days, and the resulting larvae bore into the wood and begin making their tortuous mines. The larvae grow to be about one-half inch long the first year and are very delicate. They feed by tunneling and boring in the sapwood and heartwood for three years or more before forming the enlarged pupal cell near the surface of the wood, where they spend the pupal or resting stage prior to transforming to the adult, or final overwintering stage. Observations on exposed faces, the history of which was known, have shown that the larval period is at least three years and that there is no emergence within that time. Turpentine faces exposed by burning during the winter of 1923 and 1924 and open to attack in

the spring of 1924 showed emergence in 1927 (three years later) and again in 1928. Other faces similarly exposed during 1925 and 1926 and subject to attack in the spring of 1926 showed emergence in 1929 (three years later) but none in 1928 (two years later). Table 1 substantiates these conclusions.

TABLE 1.—*Larval period of the turpentine borer as shown by the interval between attack on trees and subsequent emergence of beetles*

Tree No.	Year exposed to attack	Year examined	Emergence		Period of larval feeding
			Number of beetles	Age or condition of beetles	
142.....	1925	1928	1	Newly emerged.....	Years 3
253.....	1925	1928	2	do.....	3
(1).....	1925	1928	2	do.....	3
(1).....	1925	1929	2	do.....	4
251.....	1925	1929	2	1 year old.....	3
(2).....	1925	1929	1	do.....	3
(2).....	1926	1929	1	Newly emerged.....	3
88.....	1926	1929	1	do.....	3
122.....	1926	1929	2	do.....	3

¹ Unnumbered tree (history well known) situated near 253.

² Or less.

³ Unnumbered tree (history well known) situated near 251.

ECONOMIC IMPORTANCE AND EXTENT OF INJURY

It has long been recognized that the turpentine borer presents a serious problem in the naval stores region. The results of its depredations are apparent, not only in young stands which are being worked at present but also in old turpentine orchards. Injury by this insect is found over the entire range of longleaf and slash pines. The botanical ranges of longleaf and slash pines are given in Figure 6, which also represents the potential area of naval stores production. However, the actual production is at present confined to a limited area where the second-growth stands have reached a size suitable for turpentine. Loblolly pine (*Pinus taeda* L.), when injured, is also subject to attack by the borer, but since this tree is not worked for turpentine the damage to it is very limited.

A large share of the annual losses occurring in turpentine operations through windfall can be traced directly to the work of the turpentine borer. Besides the ordinary annual toll in exposed turpentine trees, there are especially severe losses during windstorms which occur more or less regularly over a large part of the southern pine country.

Reports of large areas of windfall timber in the turpentine belt have appeared from time to time, but the damage has generally been attributed entirely to some other factor, the turpentine borer seldom receiving its full share of the blame. However, a large percentage of the annual windfall, particularly in the second-growth stands which have been so extensively operated in late years, is caused by this beetle. In commercial practice it is not uncommon to see fallen timber and abandoned faces, the result of damage by the borer, scattered throughout old turpentine stands. After a single storm one

operator in southern Georgia lost 12 of his 50 crops of timber, and the greater part of them showed characteristic borer damage. During a storm in 1928 so much timber was blown down in the turpentine belt that there was considerable fear of developing bark-beetle epidemics in the injured timber, and many requests for information on the proper handling of this material were received by the Bureau of Entomology.

The most severe cases of damage from windfall occur in the timber in which the old box method of turpentineing is used. This is due partly to the direct effect of the boxes and partly to borer damage. Many of the boxes have been repeatedly burned and have been exposed to insect attack for a comparatively long time, with the result

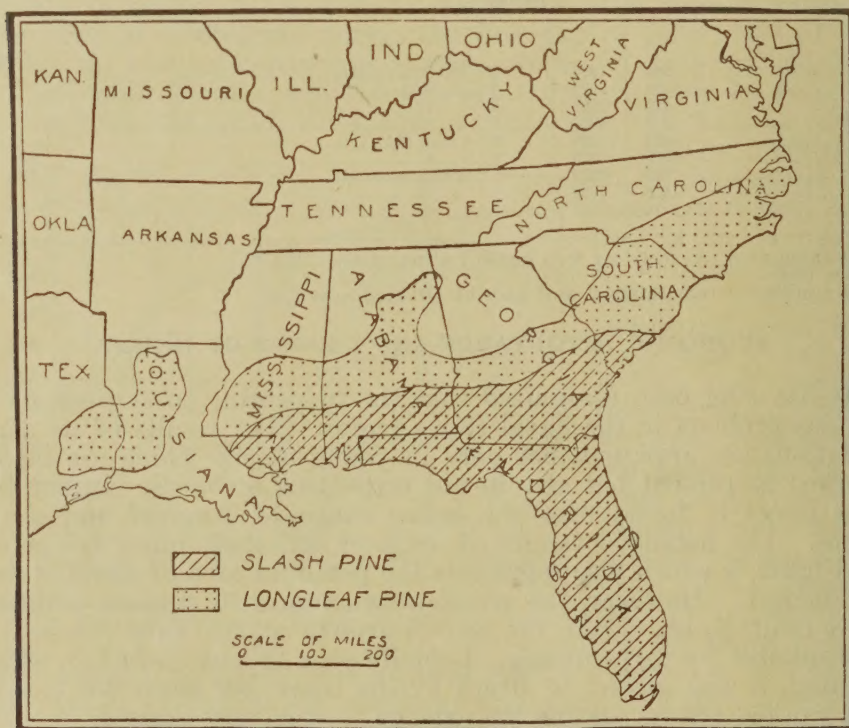


FIGURE 6.—The botanical range of longleaf and slash pines; also the potential area of naval stores production, which is much larger than the actual area now in producing condition. (From U. S. Dept. Agr. Bul. 1256)

that the wood which has not been burned out becomes badly tunneled by the feeding of numerous larvae. In one section of private timber which was boxed about 20 years ago a count made to determine the percentage of infestation showed that 97 per cent of the trees were very evidently infested, and there is little doubt that all were infested. Numerous counts of boxed timber in windfall areas have failed to reveal fallen boxed trees with no borer damage, and in practically all the fallen trees borers were found to have been an important factor contributing to their breakage. (Fig. 7.) This is further emphasized in the windfall study of 1929, which showed that of the fallen trees examined in boxed timber only 2 per cent broke at the position of the old boxes. The break more often occurred 5 or 6

feet above the ground and almost invariably at the place of heaviest borer damage. However, in many broken trees it is difficult to determine the place where the initial fracture occurred. Insect injury in such cases can not be accurately measured.

After a severe windstorm in September, 1928, studies were made on tree breakage in turpentine areas in southeastern Georgia and northern Florida. The study was made in cooperation with the Southern Forest Experiment Station in an attempt to determine the cause of windfall in turpentine orchards. Close observations were

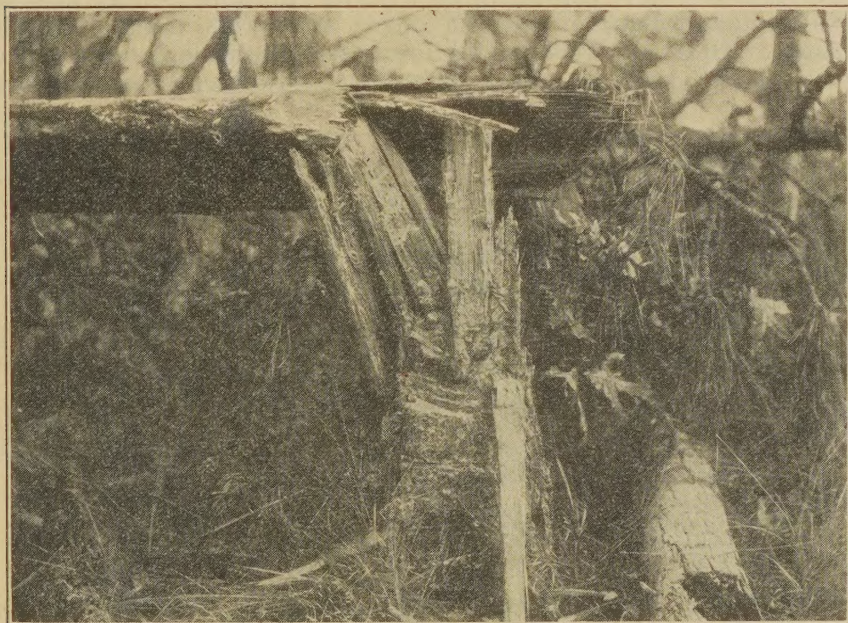


FIGURE 7.—A wind-thrown tree, a direct result of heavy damage by the turpentine borer (*Buprestis apricans*). Note the pitchy boring dust

made on sample strips 10 chains long by 1 chain wide through representative areas. The general trend of the most important findings on borer damage is shown in Table 2.

TABLE 2.—Damage by the turpentine borer as determined from studies of wind-thrown timber

Plot No.	Number of trees	Trees showing borer damage to be—				Plot No.	Number of trees	Trees showing borer damage to be—			
		Heavy	Moderate	Light	None			Heavy	Moderate	Light	None
1.....	14	9	4	0	1	7.....	14	12	0	1	1
2.....	13	10	3	0	0	8.....	14	8	4	2	0
3.....	11	6	2	2	1	9.....	8	0	2	4	2
4.....	11	4	2	2	3						
5.....	15	5	1	3	6	Total...	110	58	21	17	14
6.....	10	4	3	3	0	Per cent....		53	19	15	13

These plots were taken on many different ages and types of operation under the application of different operators, the method used

being supposedly standard American. They are representative of the conditions existing throughout the naval stores region. They were taken on private tracts, and in most cases the faces (at least the highest face) were 8 or 9 feet high. About 20 per cent of the trees examined contained but one face, the greater number had two, and a few had three. A few of the trees had old boxes on them, and in some cases the break occurred as low as the box injury. Plots 1, 2, and 3 are located on the Sampson Lake tract near Starke, Fla., and are typical of severely worked areas of slash pine. The method of working is the wide American face. The chipping is deep and the faces high, and many of them have been exposed to insect attack by burning. (Fig. 8.) Plots 4 and 5 represent the wide American face in a stand of longleaf pine. The work, however, is an improve-



FIGURE 8.—Windfall on plot No. 2, a stand of slash pine infested by the turpentine borer (*Buprestis apicans*). The borer damage on this plot is summarized in Table 2

ment over that in the other plots. Only a small percentage of the faces had been burned since they were worked, and the back faces on some of the trees were still being worked. This tract represents a fairly good type of operation. Some of the faces are still too new and too well protected to show much insect attack. Plot 6 was taken in an old stand of longleaf pine where the wide American face was used. Very few faces on this area had been burned, although most of the trees had two complete faces on them and the operation was an old one. The area was unusually well protected from fire. Plot 7 also represents an old stand of longleaf pine which had been partly boxed and subsequently chipped, and fire had run wild through most of the stand. The faces were wide, and old boxes and bad burning so exposed them that they were badly riddled by borers. Much of the stand was wind thrown. Plot 8 represents the standard Ameri-

can face in longleaf pine where the old faces had been well protected from fire. The operation on this area had ceased, and most of the trees had two high faces on them. Plot 9 represents the newest or latest operation visited, the trees still being worked for turpentine. The faces were too new for insects to be much of a factor in the losses.

A total of 110 fallen trees on nine plots or strips were carefully examined to determine the number and height of faces and the height and cause of the break. It will be seen from Table 2 that of the sample trees studied 53 per cent contained heavy borer injury at the point of the break, and in these cases the borer was held to be directly responsible for the initial fracture. Nineteen per cent of the trees showed moderate borer damage, and in this group insects were a factor contributing to the breakage. In 15 per cent of the trees borer damage was light and contributed less to the breaking than in the foregoing cases. In only 13 per cent of the trees could no borer damage be found, and the faces on these were largely new ones on which exposure had not yet occurred. In 87 per cent of the

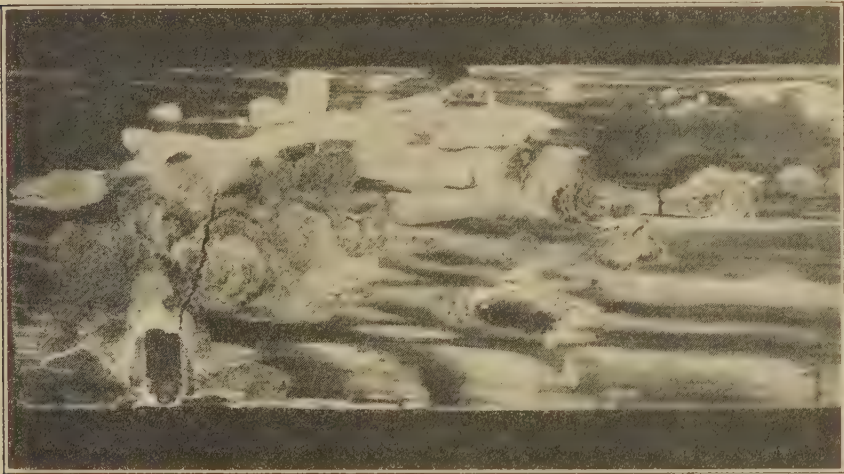


FIGURE 9.—Board sawed from log infested with turpentine borers. Note adult beetle replaced in pupal chamber. Such lumber is worthless, except for fuel wood

wind-thrown turpented trees the borers were a factor contributing to the breakage. Of these 19 per cent broke at the top of the back faces, which appeared to be the weakest places. However, the remaining 81 per cent broke between the top of the face and the box or the gutter insertion, which is usually the point of the most severe borer damage. Similar plots taken during other years without attempt to locate areas of high wind velocity or heavy windfall have shown that practically all the trees that have broken off in old turpentine stands have gone down as a result of heavy damage by borers.

As stated before, other losses than increased wind throw occur in timber infested by borers. A tremendous loss occurs annually in the lumber industry. (Fig. 9.) One forester of a private timber tract of 250,000 acres in southeastern Georgia says that the butt logs of borer-infested timber have no sale value. In a timber sale completed in the Choctawhatchee National Forest in 1926, 25 per cent of

the timber was culled, the greater part of it because of defective butt logs resulting from the work of this insect. One lumberman in southern Georgia reports leaving in the woods the lower 10 to 12 feet of each turpented tree because of heavy damage by borers. These cuts were not suitable material for ties, as ties showing even a small amount of borer damage are commonly referred to as "dusters" and are rejected. As a result, the lower 10 feet of trees which should produce a good cut for lumber is left in the woods to decay.

There is no doubt that gum production, especially on back faces, is materially reduced where the old faces have not been protected from the turpentine borer. This is especially true in thin-sap slash pine. The developing larvae work behind the old faces and next to the living wood at the corners of the faces. They continually reduce the width of the shell of living wood which should contribute to a new face. The chipping on back faces often exposes tunnels which have been bored completely around the tree. Where tunnels are approached by chipping, dry facing occurs and the trees are thus lost for further working. Unprotected back-cupped trees, in which borers have eliminated a large portion of the living wood which would normally be expected to produce gum, can yield but a portion of the gum they would otherwise produce. This loss can not be accurately measured, but that severe damage of this type occurs in most back-cupped stands can be easily demonstrated.

The Forest Service has pointed out that turpenting is but an intermediate step in the production of lumber. The two industries need not necessarily conflict. Trees properly worked and protected during the turpentine operation, with protection from fire after the operation, will pay not only the owner of the timber but the operator as well, and will remain standing to produce lumber of a good grade, free from borer damage. The benefits derived from the use of proper methods of working timber and protecting it from injury by borers are fourfold: Heavy losses from windfall are largely prevented; highest gum production from a maximum number of trees is insured; labor is saved; and a better grade, as well as a much greater volume of lumber, is produced.

COMPARISON OF TURPENTINING METHODS AND CONDITIONS FAVORING ATTACK

In order to obtain some specific information as to the relative merits of the various systems of turpenting that have been used in the past and to determine the conditions most favorable for attack by the turpentine borer, sample strips, on which tallies were run, were taken on typical sections in various parts of the Choctawhatchee National Forest, in Florida. The sample strips, with the exception of one in boxed timber, were taken from Government-supervised work and represent a type of work far superior to the average found throughout the region; therefore in all these strips losses from the borer are relatively low. A tally of 400 trees was made on most of the experimental methods, following preliminary samples of 100 to 300 faces on each of the methods. The results are briefly summarized in Table 3.

TABLE 3.—*Infestation by the turpentine borer in Choctawhatchee National Forest, Fla., under various turpentine methods*

Type of face used	Total faces examined	Infested faces		Burned infested faces ¹	Unburned infested faces
	Number	Number	Per cent	Per cent	Per cent
French ²	400	34	8.5	2.8	5.7
Narrow American.....	400	59	14.8	4.5	10.3
Combination French-American.....	200	28	14.0		
Standard Forest Service.....	400	75	18.8	2.3	16.5
Boxes ³	200	194	97.0	97.0	0

¹ Practically all fire-scarred faces were infested, with the exception of those burned within the last two or three years, on which it was too early for exit holes to appear.

² See Figure 13.

³ Private timber.

Observations on these and hundreds of other infested turpentine trees throughout the naval stores region revealed the conditions most favoring attack by the turpentine borer. Infestation by this insect occurs only on wood which has been exposed in such a way that it checks and thus opens crevices for insertion of the eggs by the female beetle.

This checking may be the result of (1) fire burning off the protective coating of gum, [fig. 10], (2) too deep scraping, which removes all the gum and exposes the wood beneath, (3) drying out of the wood on the ridge between the two angles of the same face, (4) drying out of the wood as a result of dry facing, or (5) drying out of the wood as a result of deep cuts being made for the insertion of gutters. [Fig. 11].⁵

Checking may also be caused by jump streaks. (Fig 12.) The square wooden pegs used in the last few years for supporting cups sometimes cause cracks above and below the point of insertion. These cracks do not always fill with pitch and thus afford another possible source of borer attack. Practically all these cases, with the possible exception of dry facing, are preventable, and it has been demonstrated by the Southern Forest Experiment Station that conservative turpentine methods greatly reduce this defect.

Fire is by far the most important single factor which makes turpentine trees susceptible to attack by the borer. While the faces are being operated they are usually protected from fire by raking, by fire lanes, and by other precautions. The most serious injury begins when worked faces are abandoned and left unprotected. Fires usually occur within one or two years after turpentine, and because of the accumulation of gum at the bottom of the faces practically all the faces burn. All the protecting gum is burned off, and little or none runs out to take its place. Sometimes faces escape one fire only to fall victims to subsequent burning. The blackened exposed faces are ideal breeding places for the next flight of beetles. When exposed turpentine trees are reworked, usually after a few years' rest period, they are already heavily infested by borers and can not yield as they should. In these reworked trees windfall is also extremely heavy, and much potential lumber is either ruined or lost entirely. Turpentine faces must be protected from fire at all times if they are to be kept free from damage by the turpentine borer.

⁵ CRAIGHEAD, F. C. THE TURPENTINE BORER ON THE FLORIDA NATIONAL FOREST. Forest Worker 3 (4): 11-12. 1927.

Infestation is by no means associated only with the burning of the faces, but it commonly follows their exposure to fire for a number of years. Thus it is necessary to adopt methods of turpentine which can be used on a long-time schedule without exposing wood which will check and permit insertion of eggs of the borer.

Scraping too deeply tears off slivers and large pieces of wood, leaving wounds which do not become recoated with gum, and these

exposed places are thereafter open to attack. Smooth, clean faces left with a light coating of gum are protected from borers. It may even be advisable, with some low-producing trees, to have an additional streak put on the faces at the end of the turpentine period to stimulate the activity of the resin ducts and cause an increased flow of gum.

A wide face with a high peak dries out rapidly, resulting in checks through which the borers may enter. Methods of turpentine that tend to eliminate this source of infestation should be adopted. From the standpoint of protection from borers, narrow, shallow faces have a distinct advantage.

Dry facing is not so easily prevented as are the other causes of infestation, but this source is not nearly so widespread or general as are the others.

It is most serious in slash pine, in old, thin-sap trees, and in crowded stands of young trees.

Deep scars for gutter insertion cut off the flow of gum and kill some living wood. (Fig. 11.) Gradually the upper edges of the scars dry out, curl up, and permit borer infestation. Light scars, just deep enough to hold the tins, usually fill up with gum and remain covered. Tacked tins are better still. They give better protection from insects and are being used by many progressive operators.

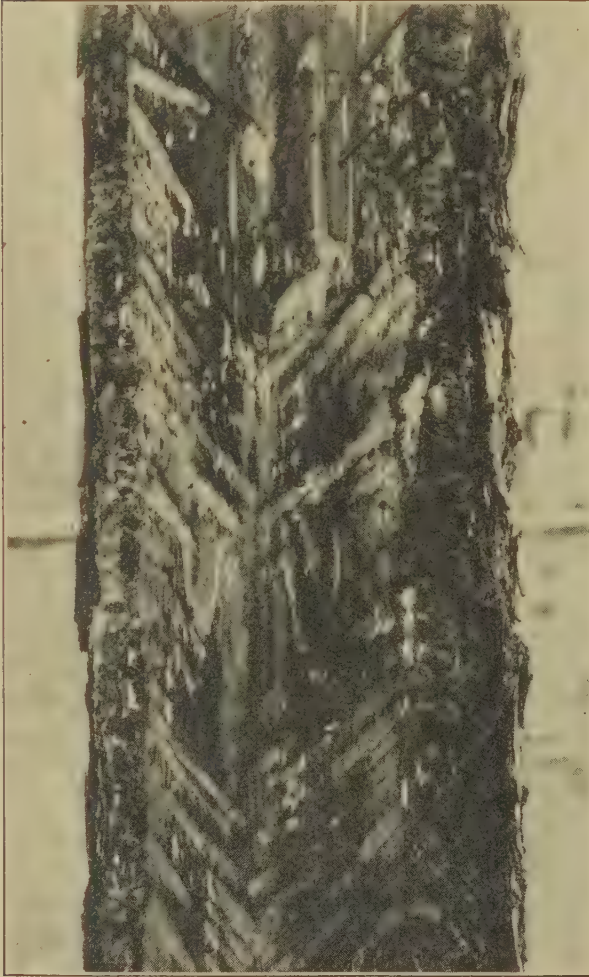


FIGURE 10.—Turpentine face heavily infested by turpentine borers after burning. Note emergence holes, checked wood, and adult beetle on right edge of face

Jump streaks (fig. 12) offer ideal spots for borer infestation, as the isolated bars of wood, having little or no living tissue connecting with the rest of the tree, dry out rapidly.

Any operation or method of turpentineing that results in the formation of checks or exposed wood, even in very small spots, is undesirable and should be replaced by a better method.

The examinations of infested trees, together with the check on different methods of turpentineing, clearly indicate the advantage of the narrow concave face, which is typical of the French method. (Fig. 13.) The box method, admittedly a very poor one, is little used to-day and need not be discussed under possibilities of preventing borer attack. It has been included in the examinations because



FIGURE 11.—Turpentine face showing deep cut for gutter insertion, a source of attack by the turpentine borer. Note emergence holes. The horizontal ax cut allows the wood to dry and curl and permits egg laying by the insects

of the many areas of old boxed timber which are still suffering from this old practice and because a few of the small-scale operators are still using this method. It has been found⁶ that the weakest point of systems other than the French is the incision made in the wood for gutter insertion. (Fig. 11.) Attack occurred at this point in more than 90 per cent of the infested faces examined. The real advantage of a narrow concave face is believed to be due to the fact that the wood behind the face becomes thoroughly

impregnated with pitch for a depth of one-half to $1\frac{1}{2}$ inches. Even though the surface gum weathers away, this saturated wood apparently serves as an effective barrier to egg laying. The weakest point of the American face lies in the convex peak where the wood does not become so well saturated with resin as at the shoulders, and where it has a greater tendency to dry and check.

Several workers have suggested that a split American face (fig. 14) be tested for immunity to attack by the turpentine borer. The essentials of the split American face are that a strip of bark 3 or 4 inches wide remain between the two faces in the position occupied by the peak of the present face, the theory being that this prevents a certain amount of drying and checking. It is believed that the

⁶ CRAIGHEAD, F. C. Op. cit. (See footnote 4.)

advantages of such a system would approach those obtained by the French method (fig. 13) and that this face would be thoroughly effective in preventing borer attack. The practicability of this method can be determined only by a thorough field test. Such a test is now being made at the Southern Forest Experiment Station. The split face may have advantages over the French method in that it might be more readily adopted by American operators and that it would permit the use of familiar tools, whereas with the French



FIGURE 12.—Smooth turpentine faces with a protective covering of gum are ideal protection from the turpentine borer. The burned half of one face and the jump streaks (raised bars of wood) are susceptible points on the faces shown here

method new equipment would be necessary.⁷ On the other hand, because of the unsatisfactory type of labor available, a modified French method might be desirable and less injurious to the trees when practiced by careless or inexperienced operators.

CONTROL

When the turpentine borers have once entered a tree there is no known method of getting rid of them, and when trees have once been exposed by burning of the faces, rough work, or any of the other ways described in this bulletin, there is no practical method of stopping attack by the borers.

Prevention is the only known remedy. Practically all the

damage to turpentine orchards by the turpentine borer can and should be prevented. Protection of worked faces from fire is absolutely essential, as all faces that are burned become infested during the next flight period of the beetles.

The conservative turpentering technic of the United States Forest Service as applied by the Southern Forest Experiment Station will prevent practically all infestation by the turpentine borer. Briefly,

⁷ MCKEE, E. R. THE FRENCH TURPENTERING SYSTEM APPLIED TO LONGLEAF PINE. U. S. Dept. Agr. Circ. 327, 16 p., illus. 1924.

this consists of shallow chipping (especially at the peak), relatively narrow faces, and fastening of tins by tacks or nails, rather than by incisions in the wood. Where a streak is cut at a rather flat angle, the danger of dry facing occurring at the peak is less than where the angle of the peak is sharp. In addition, careful scraping, in order not to remove any of the wood, is a prime requisite. Shallow chipping prevents attack through lowering the percentage of dry faces.



FIGURE 13.—New French turpentine face which, by its shape and narrow width, practically prevents attack by the turpentine borer



FIGURE 14.—Split American turpentine face which, it is believed, has all the essentials for complete protection from infestation by the turpentine borer

It is necessary to keep a coating of gum over the faces at all times to prevent egg laying by the adults. The degree of infestation will be proportional to the care exercised in operation. Under the present system of turpentineing, personal supervision of the operation is undoubtedly the principal factor in the prevention of infestation by the turpentine borer.

SUMMARY

The turpentine borer presents a serious problem in the naval stores region. It is undoubtedly the most destructive pest of turpentine orchards in the South. The heaviest losses resulting from

borer damage are caused by windfall. Other losses which occur in borer-infested timber are due to lowered grades of lumber and decreased gum production.

The turpentine borer attacks principally the faces of longleaf and slash pines which have been exposed by fire or otherwise injured. The larvae of this borer tunnel through the sapwood and heartwood of the main trunk of infested trees and not only render much of the timber worthless, except for fuel, but also weaken the trees so that they break off easily and many of them fall, especially during severe windstorms.

The young borers feed for a period of at least three years before constructing their pupal chambers near the surface of the wood, where they transform to the adult or beetle stage. After emerging in the spring, the adults feed on the pine foliage for a few weeks. The beetles mate during the feeding and flight period, after which the females seek exposed wood or checks of any kind in which to deposit their eggs.

Practically all the damage to turpentine orchards by the turpentine borer can be prevented by the adoption of improved turpentin-ing methods and absolute fire protection for the worked faces. The standard turpentin-ing technic of the United States Forest Service offers the maximum protection from borer damage.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
WHEN THIS PUBLICATION WAS LAST PRINTED

<i>Secretary of Agriculture</i> -----	ARTHUR M. HYDE.
<i>Assistant Secretary</i> -----	R. W. DUNLAP.
<i>Director of Scientific Work</i> -----	A. F. WOODS.
<i>Director of Regulatory Work</i> -----	WALTER G. CAMPBELL.
<i>Director of Extension Work</i> -----	C. W. WARBURTON.
<i>Director of Personnel and Business Administration.</i>	W. W. STOCKBERGER.
<i>Director of Information</i> -----	M. S. EISENHOWER.
<i>Solicitor</i> -----	E. L. MARSHALL.
<i>Weather Bureau</i> -----	CHARLES F. MARVIN, <i>Chief.</i>
<i>Bureau of Animal Industry</i> -----	JOHN R. MOHLER, <i>Chief.</i>
<i>Bureau of Dairy Industry</i> -----	O. E. REED, <i>Chief.</i>
<i>Bureau of Plant Industry</i> -----	WILLIAM A. TAYLOR, <i>Chief.</i>
<i>Forest Service</i> -----	R. Y. STUART, <i>Chief.</i>
<i>Bureau of Chemistry and Soils</i> -----	H. G. KNIGHT, <i>Chief.</i>
<i>Bureau of Entomology</i> -----	C. L. MARLATT, <i>Chief.</i>
<i>Bureau of Biological Survey</i> -----	PAUL G. REDINGTON, <i>Chief.</i>
<i>Bureau of Public Roads</i> -----	THOMAS H. MACDONALD, <i>Chief.</i>
<i>Bureau of Agricultural Engineering</i> -----	S. H. MCCRORY, <i>Chief.</i>
<i>Bureau of Agricultural Economics</i> -----	NILS A. OLSEN, <i>Chief.</i>
<i>Bureau of Home Economics</i> -----	LOUISE STANLEY, <i>Chief.</i>
<i>Plant Quarantine and Control Administration.</i>	LEE A. STRONG, <i>Chief.</i>
<i>Grain Futures Administration</i> -----	J. W. T. DUVEL, <i>Chief.</i>
<i>Food and Drug Administration</i> -----	WALTER G. CAMPBELL, <i>Director of</i> <i>Regulatory Work, in Charge.</i>
<i>Office of Experiment Stations</i> -----	JAMES T. JARDINE, <i>Chief.</i>
<i>Office of Cooperative Extension Work</i> -----	C. B. SMITH, <i>Chief.</i>
<i>Library</i> -----	CLARIBEL R. BARNETT, <i>Librarian.</i>

This circular is a contribution from

<i>Bureau of Entomology</i> -----	C. L. MARLATT, <i>Chief.</i>
<i>Division of Forest Insects</i> -----	F. C. CRAIGHEAD, <i>Principal Entomologist, in Charge.</i>

